JANUARY, 1941

ONE SHILLING

Plastics

DEALING WITH THE MANUFACTURE USES AND POTENTIALITIES OF PLASTIC MATERIALS

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Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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PLASTIC WINGS OVER THE EMPIRE

THOSE who still maintain that the plastic aeroplane is merely a pipe dream will be shocked out of their static-mindedness by the recent report from the Department of Munitions in Ottawa that the Canadian Government has obtained the exclusive rights in Canada for the Vidal plastic process for aircraft production. Furthermore, it has ordered two plastic fuselages to be given "destruction" tests. The Director of Aircraft Production has said that if these were successful the plastic aircraft would assure a substantial reduction in cost in addition to resulting in greater output. So far as we know the following processes are known to have approached examination by Government authorities—doubtless there is a German process also.

(1) The Aero Research, Ltd., process of Great Britain which has been developed by Dr. de Bruyne. In the main this consists of producing strong structures for aircraft production from planks made by what is almost an extrusion process. The endless planks are made by impregnating an orientated fabric and "curing" by heat and pressure. Their strength is claimed to approach reasonably closely to that of metal and moreover they can be machined simply and quickly into any size and shape. This process thus entirely avoids the use of special moulds and of plywood.

(2) The Timm Aircraft Corporation process developed at Los Angeles.

(3) The Duramold process initiated by Colonel V. E. Clark and promoted by the Haskelite Corporation and the Bakelite Corporation of U.S.A.

(4) The Vidal process developed by Eugene Vidal and promoted financially by a Mr. Ottinger, head of U.S. Plywood Co.

The three named American processes differ from the British process in utilizing plywood, impregnating the sheets with resin and curing or forming in a simple type of mould.

Among themselves the three processes do not appear to differ fundamentally, but do differ in detail. For example, in the Duramold process the male portion of the mould is of rubber and the female portion is of cast iron. In the Vidal process the male portion is rigid. The resin-treated veneers are placed round this rigid shape, a rubber bag is drawn over them and the whole is subjected to steam pressure. Perhaps the best description of the Vidal process is given in the January, 1940, issue of that very remarkable monthly magazine, *Fortune:*—

". . . at Bendix Airport, near the New Jersey end of the George Washington Bridge, a small, unprepossessing brick factory building houses Mr. Eugene Vidal, until 1937 head of the Bureau of Air Commerce. Mr. Vidal is now the president of a small company called the Aircraft Research Corp., and the tie between Mr. Ottinger and Mr. Vidal is that Mr. Ottinger will produce in quantity the models developed by Mr. Vidal, who thereby hopes to get plywood back into the air with a bang. He wants to see airplanes with moulded plywood wings and fuselages, their reinforcing plywood members integrally bonded to them. To achieve this end he is currently working with big wood moulds, vacuum bags, steam-pressure tanks and mahogany veneers.

"For the purpose of simplicity assume that Mr. Vidal wants to mould a canoe, not an airplane wing. His wooden mould—a 'male' in the terminology of the foundry—would look like a canoe turned upside down. If a keel were to be moulded in the canoe's bottom he would cut a groove in the top of his mould, and lay the plywood keel along it. If gunwales were to reinforce the canoe's top, he would 'slot out' his mould for them at the bottom. Where he wanted other reinforcing members he could alter his easily constructed mould to accommodate them.

"And those are the simplicities that he adapts in his experimental moulding of plywood wing and fuselage sections. The reinforcing bars of preformed plywood are placed where needed. Then over the whole are draped sheets of resin-coated veneer. Mould and plywood sheets are now encased in a rubber-like bag from which the air is exhausted to keep the materials clamped together. Thereafter steam heat and pressure do their work on the thermo-plastic resins, and the

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softened veneers cling to the mould and the reinforcing members. A cold-air blast sets the resin, the mould is disassembled, and there you have your complex plywood shape, the reinforcing members integrally cast.

"So far, Vidal has designed and constructed wing sections and other parts for a small plane, and they have made a satisfactory score in their static tests. The designs are to be used in meeting a contract for 100 private planes, two-seater cabin monoplanes with retractable landing gear, presumably underselling the $2,900 Stinson but priced considerably more than the '$700 plane' that Mr. Vidal once so energetically publicized. (However, the low-priced plane is actually the objective of the company.) Eventually, U.S. Plywood will build them at its Algoma plant."

It will be noted that whereas the Duramold process employs phenolic resin solutions as the impregnating agent, the Vidal process is stated above to employ thermo-plastic resins. It has also been stated that these thermo-plastic resins are of the polyvinyl butyral type, which arouses further interest as to the method of such impregnation, for, obviously, real impregnation by polymers is difficult. It raises the problem as to whether it is possible first to impregnate with the simple monomer and then to polymize *in situ*.

It is not clear whether anything beyond training machines is contemplated by any of these processes. What is clear, however, is that were any of them successful in making the larger planes, a stupendous saving in time and of metal would be made. We once mentioned that some 50 per cent. of aluminium is wasted in metal aircraft manufacture. This we believe to be an underestimate. We can therefore expect considerable resistance from the aluminium producing industry in any future projects for the plastic aeroplane.

In spite of any opposition, however, the plastic aeroplane, at least of the trainer type, is a probability.

Brass for Essentials

A RECENT issue of the *Hardware Trade Journal* complains bitterly of the difficulty of getting brass. "Brass cannot be released (by the Board of Trade)," it says, "for the manufacture of curtain rail fittings; for one thing, the fittings are not considered as being of 'a high state of fabrication,' and for another the brass is required for the Services. Last Saturday, we remember, we read a story in the daily newspapers which told us that the Army is about to get another 200,000,000 brass buttons. These, of course," it adds sarcastically, "are real essentials. There could be no question of a substitute material being used. There were brass buttons in the last war and there must be brass buttons in this. What does the plastics industry say about it?"

We sympathize greatly with the hardware trade for we have little respect for the spit and polish brigade. To the 200,000,000 brass buttons can also be added the brass regimental badges and shoulder letterings, although here there is much to say for their continuance. However, we had understood that most of the buttons on the modern Service uniform were not of brass. Certainly millions for the Navy, Army and Air Force are being made of casein and moulded synthetic resin. It is not beyond the realms of possibility that to the daily journalistic mind if the word soldier's button is mentioned it must automatically be of brass.

A New Book

PLASTICS IN INDUSTRY. *By "Plastes."*
(Chapman and Hall, Ltd. ∴ Price: 12/6 net.)

IT is rarely that one can describe a technical work as exciting. Excitement in technical journalism usually means inaccuracy. The exciting part of *Plastics in Industry*, however, lies in its combination of convincing accuracy with an imaginative prognosis of future developments in the plastics industry. It is a book sufficiently simple for the industrialist without advanced technical knowledge to understand but sufficiently novel and informative for chemist, physicist and engineer to read with benefit and interest.

Plastics in Industry was completed during the present war, and in its detailed analysis of the present applications of plastics to industry gives, as it were, the Midnight News of these developments. Less skilled writers than the authors of this book might have antagonized their readers by a too enthusiastic view of the possibilities of plastics. Not so "Plastes." If anything, they err on the side of understatement. They do not believe that this is a Plastic Age in which plastics will entirely supersede other materials. On the other hand, they consider that the application of plastic materials has only conquered the outposts of industry. They repudiate the traditional ideas of those who think of plastics in terms of ash trays and toothbrush handles only and support their point by reference to the manifold possibilities of their use in the electrical, aircraft, automobile and building industries. Amiably but devastatingly, they criticize those industrialists who say, "Ah, well, plastics are all right, but they're three times (four times, five times, six times) as expensive as the materials I'm using." The great fallacy of this argument lies not only in the economy of moulding over other constructional methods, but also in the properties of plastic materials themselves which in application, upkeep and durability well compensate for their basic excess cost.

It would be wrong to imagine that this book merely deals with generalizations. The authors deal successively with each industry and give details of the plastics at present in use, together with their method of production and mode of application. Thus, *Plastics in Industry* can be said to be a manual for the works manager who is using or wishes to use plastic materials.

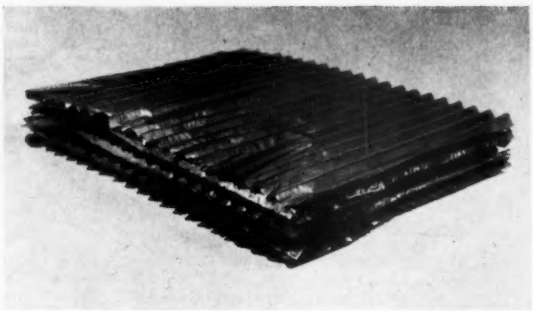
Thirty-two excellent contemporary illustrations add to the value of the book. Imaginative in conception, accurate in detail and convincing by its objectivity, *Plastics in Industry* stands out among the current works on plastics in industry like a mountain among its foothills.

MAURICE EDELMAN, M.A. (Cantab).

The New Year

The year that has passed has been one full of anxiety for all of us and of tragedy for some. The coming year will be an anxious time, too, but so great has been the resuscitation of the British spirit in the Services, in the factories and in the fields that we look forward with even greater confidence to the conclusion of this war.

To all our friends, then, in and out of the plastics industry, we send our warmest greetings for a Happy New Year.



ISOFLEX

A New Insulating Material Manufactured from Cellulose Acetate Sheet

OUR editorials in the November and December issues, entitled "Plastics for Refrigeration," and "Spongy Plastics," have aroused considerable interest, especially as it was the first time that the relative insulating properties or rather thermal conductivities of plastic materials and the normal insulating materials have been put down in print. It will be remembered that we made the following remark:—"It seems strange that some of the thermo-plastics with their low thermal conductivities and other advantages of transparency and stability at low temperatures have not been seized upon as suitable materials for insulation in the home of refrigerators—the United States of America. Perhaps, too, we shall see one day an expanded type of thermo-plastic filled with myriads of air-cells and yet strong enough to withstand considerable rough treatment."

To-day, although we have not yet reached this type or stage, we can show that thermo-plastics for the purpose of insulation are now in actual use, with considerable success.

General Characteristics of Isoflex

Mr. Birrell, of BX Plastics, Ltd., has written us referring to our editorials and gives us some extremely interesting information regarding a new low-temperature insulating material named Isoflex that his concern has recently put on the market.

Its form can best be visualized from either of the two photographs on this page. Built from thin cellulose acetate sheet it is corrugated in form with connecting interlayers of flat sheet so that a cohesive structure is obtained. There is thus provided a system of air spaces made from a material itself of low heat-conducting power. It will immediately be observed that we have also an extremely light material, many times lighter, indeed, than all the well-known insulators—one cubit ft. weighs ¾ lb. This is roughly one-tenth the weight of the widely employed slab or granulated cork.

Properties of Solid Plastics

In our November issue we gave a list of the thermal conductivities of various plastics:—

Phenol-formaldehyde mouldings ...	0.0005
Urea-formaldehyde mouldings ...	0.0007
Laminated phenolics	0.0005
Cast phenolics	0.0004
Polystyrene	0.0002
Cellulose plastics	0.0005

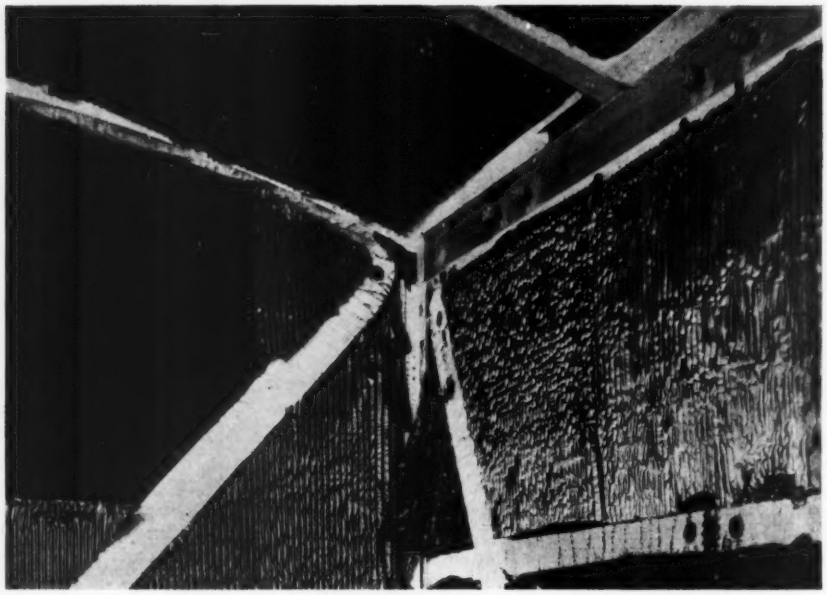
These values, of course, referred to the solid material and not to any expanded type which was then unknown to us. Perhaps the future will bring us cellular types of even thermo-setting resins.

The improvement brought about in thermal conductivity of cellulose acetate by the process of corrugation can be seen from the following comparative figures of Isoflex and cork, rubber, etc.:—

	Thermal conductivity. C.G.S. units.	B.T. units.	lb. per cubic foot.
Isoflex	.00011	.32	0.75 lb.
Slab cork ...	.00009	.25	6.0 lb.
Granulated cork	.00010	.28	6.5 lb.
Cork wool ...	.00007	.21	3.3 lb.
Expanded rubber	.00010	.28	4.0 lb.
Expanded ebonite	.00007	.22	5.4 lb.
Wood wool ...	.00010	.28	—
Glass fibre ...	.00010	.28	—
Diatomaceous earth	.0002	.56	30.0 lb.
Wood fibre board	.00013	.38	—
Slag wool ...	.00010	.29	15.0 lb.

Since it is constructed of cellulose acetate Isoflex is not an absorbent material, so that a decrease in insulation

Isoflex is easily and quickly cut with knife or saw.



These photographs show an L.M.S. insulated container lined with Isoflex. The top photograph shows the simplicity of the process.

value does not occur as a result of exterior deposition of water. Furthermore, the form of channelling would help to remove by drainage such moisture that did collect in the structure.

Resistance of Isoflex

Another important factor to note regarding Isoflex is that it is corrosion, fungus and insect proof, which is in sharp contrast, especially regarding fungal attack, to cork slabs and similar constituted bodies, which, in view of their construction, are readily attacked, especially when animal glue is employed as a constituent. It is common practice in cork slab and sheet manufacture to incorporate germicides in the finished product.

As is general with any plastic insulator, Isoflex cannot be used for high-temperature insulation and is limited to work below 75 degrees C.

Isoflex is available in slabs in two ranges of layers and thicknesses. The so-called Standard type is sold in squares of 24 ins. by 24 ins., and consists of varying thicknesses from five layers with a total thickness of 1 in. up to 13 layers with a total thickness of 2½ ins. A second type, known as Flexible slab, is sold in 23-in. by 20-in. rectangles, in thicknesses varying from 1 in. to 2 ins.

The insulating material can be cut very readily into any desired shape, rapidly and simply, by the use of knife or saw. Curves and angles are easily produced.

Applications of Isoflex

The most important application at present in use in this country is the insulation of railway vans for the carriage of food in cold storage. The above photographs show a London, Midland and Scottish Railway container that has been lined with Isoflex. The top photograph shows the method of lining and incidentally the simplicity of the application and of the shaping of the material to conform with existing structures. The Isoflex is protected by a holding sheet. It has been utilized for this purpose and for the lining of ordinary railway carriages for some time in Sweden by the Swedish State Railways. In the same country Isoflex has been employed for the lining of caravans, for the insulation of marine air-conditioning plant and for refrigeration plant.

Isoflex has also great promise in other fields. Since it is also manufactured in transparent form it has been suggested for use in the building of greenhouses. Furthermore, as has been suggested for similarly constructed plastics, Isoflex is obviously of use in replacing broken glass windows.

Plastics for the Building Industry

The members of the Institution of the Plastics Industry will remember Mr. R. Cotterell Butler's excellent paper on the requirements of the building industry. Those who are interested in this subject will be glad to read a series of articles he has written for *The Builder*, under the general title of " War-time Building Practice."

With the November 29th issue, he deals with plastic materials, their history, manufacture and general properties. Later issues of December 12 and December 19 have dealt with the subject in a manner which is of considerable concern to the plastics industry. These articles refer to " The Practical Application of Plastics for Building " and " Designing for Production." His remarks on the advantages and disadvantages of plastics for real structural members are of considerable value for our future guidance.

ADHESIVES AND CEMENTS

The author continues his discussion on modern adhesives based on synthetic resins and here concludes that portion which deals with phenolic resins

By E. E. HALLS

IN the light electrical industry, quite a number of bobbins of various types are used as coil formers and in these end cheeks and spacers of fabric or paper laminated phenolic resin are cemented to the tubular core of rolled or rolled and moulded phenolic resin paper. While nowadays many of these are completely moulded, there are still large quantities produced by the built-up method. The reason for this is usually flexibility, and variety of types in relatively small quantities for justifying moulding tool costs. Typical forms are shown in Fig. No. 7. The end cheeks are usually made a close fit to the core, but intermediate separators are a sliding fit. The building up is a simple operation using phenolic resin cement (material to sample No. 1, Table No. 1). The cement is neatly applied to the core tube and the cheek forced into position. The assemblies are loaded into light, slotted fixtures (see Fig. No. 8) and baked. In actual practice, it is common to employ a uniformly steam-heated oven, continuously maintained at 220/230 degrees F. (105/110 degrees C.), and to insert the load for about 12 hours.

While this technique is satisfactory for parts made accurate with respect to dimensions, and of close fit, there is the tendency for the fluid resin to run away from the junction. For large components, and for those in which accuracy is not so good as it should be, a filled cement is admirable. In fact some workers employ it in all instances. The 50/50 phenolic resin cement and wood flour moulding powder is adopted. The wood flour is screened to appropriate mesh. For very tiny spools, a 50/50 mineral loaded cement can be employed. Application and baking are as above.

The same procedures are used for securing phenolic resin laminated cheeks to "paper" core tubes of electrical quality, that is, rolled tubes made from insulating paper secured with starch or dextrin adhesive.

Built up models or articles from phenolic laminated materials, sheet or tube, can quite satisfactorily be secured with phenolic resin cement. Likewise broken mouldings can be repaired. The cement is applied to the junction, the parts pushed together, and excess cement is removed, assisted by means of a cloth moistened in industrial methylated spirit. If necessary the pieces are held together by means of suitable clamping devices, and baked. Usually a long, slow bake, followed by a short high temperature cure, is most satisfactory. Most general, 24 to 28 hours at 60 degrees C., followed by 6 to 12 hours at 100 degrees C., suffices. This combination ensures hardening with good adhesion and avoidance of bubbling, embrittlement and distortion.

Varnish of the type represented by sample 2, Table No. 1, is specified for fixing small screws in electrical apparatus (radio, relays, etc.). Small screws of the BA sizes, countersunk or otherwise, after tightening or adjusting, are doped around the head and the opposite end by brush application of a little phenolic resin varnish, and merely allowed to air dry. This procedure is found sufficient to prevent loosening or loss of adjustment by vibration such as would be encountered in mobile units, aircraft or ships. The junctions may be metal to metal or metal to plastic (composite insulating material, phenolic mouldings or laminated).

The phenolic resin varnish is also used as fixative for electrical quality paper tubes. One procedure is to varnish the paper on one side by brush or roller and allow to air dry. Predetermined lengths are then wound on mandrels, which are next clamped between V blocks and loaded into steam-heated ovens. Heating is for 18 to 24 hours at 105/110 degrees C. This simple though rather crude method gives excellent results. More modern processes utilize a ready varnished paper such as one of those depicted in Table No. 3. Colour may be natural brown or black, while thickness must be in accordance with the wall thickness of the tube to be made and the dimensional tolerances permissible. Space is not available in this article to discuss the manu-

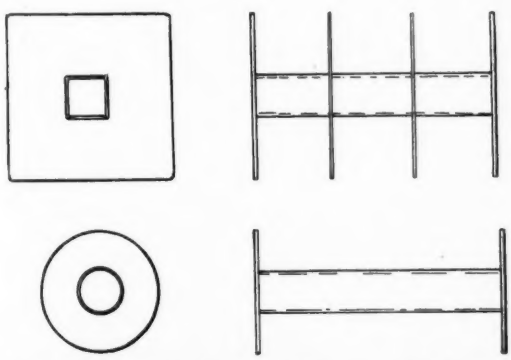


Fig. 7.—Spools—phenolized core tubes cemented to phenolic laminated cheeks.

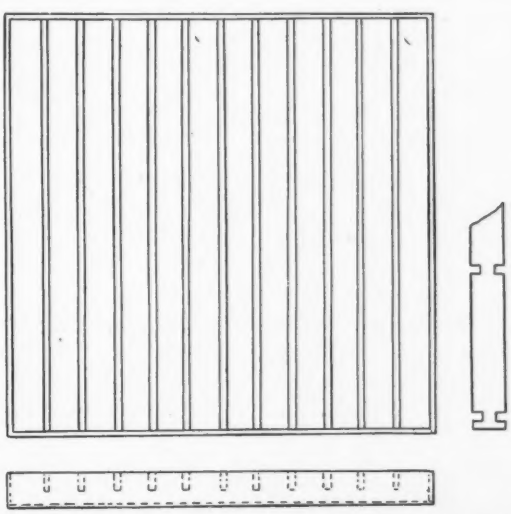


Fig. 8.—Diagram of slotted fixture for baking cemented spools. On right the slots are shown enlarged.

Table No. 1.—Characteristics of Phenol-formaldehyde Cement and Varnish.

Sample No. / Source / Description	1 A Cement	2 A Varnish
Chemical:		
Volatile Spirit (loss, 3 hours at 110°C.) %	14.2	42.0
Total Solids (phenol-formaldehyde resin) %	85.8	58.0
	100.0	100.0
Reaction	Alkaline	Slightly Alkaline
Physical.		
Viscosity at 25°C., centipoises	4,500	280
Specific Gravity at 25°C.	1.215	1.035

Table No. 1A.—Characteristics of Phenolic Resin Oil Varnishes Suitable for Air Drying or Stoving.

Sample No. / Source	2A American	2B American	2C British
Compositional, %:			
Volatile Spirit (loss, 3 hours at 110°C.)	39.5	35.0	40.0
Total film forming solids	60.5	65.0	60.0
	100.0	100.0	100.0
Physical:			
Viscosity at 25°C., centipoises	450	760	600
Specific Gravity at 25°C.	1.034	0.033	1.025
Drying time:			
Surface, minutes	15	20	15
Hard, hours	48	48	48

Table No. 2.—Characteristics of Synthetic Resin (Phenolic) Basing Cements.

Sample No. / Source	3 B	4 C	5 D	6 E
Composition, %:				
Phenolic Resin	100.0	52.5	43.6	27.5
Wood Flour	—	—	51.6	—
Mineral Filler	—	—	4.8	—
Siliceous Earth	—	—	—	72.5
Chalk	—	47.5	—	—
	100.0	100.0	100.0	100.0
Colour	Brown	Light Brown	Black	Light Brown

Table No. 4.—Characteristics of Air-drying Resin/Rubber Varnish Adhesives.

Sample No. / Source	14 A	15 H
Chemical:		
Volatile Spirit (loss, 3 hours at 110°C.) %	85.5	78.0
Total Solids (resin, rubber) %	14.5	22.0
	100.0	100.0
Physical:		
Viscosity Centipoises at 25°C.	250	3,500
Specific Gravity at 25°C.	0.834	0.855
Drying time in hours: Surface	¼	¼
Hard	4	4

Table No. 3.—Characteristics of Resin-treated Papers.

Sample No.	Colour	Overall Thickness, Inches			Resin Content %	Ash %	Substance, Grams/Sq. metre	Thickness, Paper Base, Inches		
		Max.	Min.	Mean				Max.	Min.	Mean
7	Natural	0.0066	0.0061	0.0066	38.0	0.74	156.0	0.0057	0.0047	0.0052
8	Natural	0.0028	0.0024	0.0026	42.8	0.47	61.3	0.0020	0.0015	0.0018
9	Natural	0.0032	0.0027	0.0030	31.5	0.56	68.5	0.0023	0.0017	0.0020
10	Natural	0.0045	0.0040	0.0042	43.5	0.52	81.5	0.0036	0.0026	0.0031
11	Natural	0.0080	0.0068	0.0075	44.3	0.48	157.5	0.0055	0.0050	0.0053
12	Natural	0.0095	0.0086	0.0091	47.6	0.51	187.3	0 0085	0.0076	0.0075
13	Natural	0.0041	0.0034	0.0037	47.2	0.43	88.7	0.0030	0.0025	0.0027
11a	Black	0.0089	0.0069	0.0077	48.5	0.59	160.5	0.0060	0.0052	0.0055
12a	Black	0.0101	0.0090	0.0095	47.6	0.46	185.3	0.0089	0.0077	0.0078

All samples chemical wood stock base, clean, long fibres. All samples entirely neutral in reaction.

facture of laminated tubes, but some notes on the possibilities are justified from the adhesive angle. Tubes can be made of varying quality from intense hardness, high electric strength and low absorptive properties on the one hand, to relatively soft, lower electrical quality, and higher moisture absorption on the other. Manufacturing technique entails winding the paper on a mandrel, pressing between V blocks and baking. Times of 30 to 60 minutes at 135 to 150 degrees C. give rapid production of the relatively lower grades. If, however, the V blocks are only lightly pressed together, and immediately they are heated through (say 10 to 15 minutes at 80 to 100 degrees C.) they are fully pressed, followed by final heating from 30 minutes to 3 hours at 135 to 150 degrees C., the higher quality tubes result. The adhesive paper base must contain at least 40 per cent. resin and this preferably should be in the uncured state.

Impregnated Papers for Securing Veneers

Reference must be made to specially prepared "bakelized" papers used for securing veneers and plys of built-up wood sheets. These papers are, in effect, coated or impregnated kraft paper, 0.0025-0.005 in. (0.064-0.1270 mm.) thick. The adhesive is bakelite-resin varnish. They are satisfactory for producing all types of plywood or for securing wooden veneers.

A German claim covers the use of an unsized paper of thickness 0.0015-0.0020 in. (0.061-0.081 mm.) treated with a modified resin lacquer. The lacquer mentioned contains 40-50 per cent of resin, 2-3 per cent. commercial castor oil, and 4-6 per cent. colophony resin. The dried films are claimed to be not only suitable for good wood veneers for aircraft work, but also for fixing metals such as copper, aluminium and magnesium, and their alloys, to wood.

The phenolic resin coated or impregnated papers are also used for their adhesive or securing properties in electrical apparatus for dual purposes of insulation and anchorage. Thus in automatic telephone equipment where the switch banks comprise a number of parallel layers of individual terminals spaced with dimensional accuracy between layers of phenolic laminated insulators, and clamped by bolts through outer metal plates, the terminals are held rigidly by means of an adhesive layer to withstand the transverse pull of the contacting wiper arms moving across them. One method of achieving this utilizes phenolized paper, 0.005-in. thick, 40/60 per cent. uncured resin content, and one technique of operating is as follows. The assemblage is bolted together "finger-tight," and placed in an oven at 350 degrees F. (175 degrees C.) for a period of 10 minutes. It is then passed to a press, clamped to a predetermined pressure, and the bolts driven home. Another technique first fully tightens the assemblage, bakes at 250 degrees F. (125 degrees C.) for half an hour, then allows to cool off to 140/160 degrees F. (60/70 degrees C.) and finally retightens

under controlled pressure in order to follow up natural contractional shrinkage of the components.

Phenolic resin impregnated fabric has also been used for this class of work.

Difficulties of Metal to Paper Adhesion

This terminal securing proposition is virtually a question of bright metal to paper, and using the phenolic resinous materials as above, it will be found that sound adhesion is not obtained. Thus upon disassembly, although the terminals are tightly held, gentle shock to the strip causes their detachment. Incidentally, the same occurs if the metal terminals are roughened by sand or shot blasting. The fixing is therefore not of an adhesive nature but mechanical by virtue of flow of the resin up the sides of the terminal as illustrated in Fig. No. 9. This satisfies service requirements but does not meet the occasional yet important need for disassembly to replace a faulty terminal; handling through such operations invariably causes detachment of one or more terminals. Consequently, some technicians prefer shellacked papers, using papers from 0.001 in. to 0.005 in. containing about 50 per cent. shellac. Passed through the techniques described above, these provide perfect adhesion; detachment of terminals involves thorough severance of the paper. It is claimed that by virtue of the baking, the shellacked material is quite satisfactory electrically, without tendency to deteriorate under damp service conditions. However, technicians who have qualms on this point, compromise by utilizing a mixture of shellac and phenolic resin. Mixtures ranging from 3/1 to 9/1 of a good quality 50 per cent. orange lac solution in industrial methylated spirit, and phenolic resin varnish (e.g., Table No. 1, sample No. 2), respectively, have been exploited, with, of course, best results using the higher shellac ratio. It can be adjusted for application to the paper by any of the usual commercial methods. It should be applied to both sides in all cases where insulation is important. For brush application, the formula given is satisfactory. For spray, dilution with 30 per cent. of 64 O.P. industrial methylated spirit suits an aerograph plus model gun, No. 3 nozzle. The thickness of coating as tested on the completed and dried product should be 50 per cent. total resin content, plus-minus 10 per cent.

Application of Sprayed Varnishes

Work has been carried out to determine the possibility of securing these terminals directly to the phenolic laminated insulator using a sprayed film of the phenolic resin varnish on the latter, but no better success has been recorded. However, using a specially formulated phenolic resin oil varnish, considerable advance has been effected. Characteristics of varnishes of this type, all of a similar nature, are given in Table No. 1A. These adhesive varnishes will air-dry or withstand stoving. They flash off upon application fairly rapidly although they may remain tacky for 24 or 48 hours. Baking fully hardens them, using temperatures from 100 to 175 degrees C. and corresponding times of 60 minutes and 10 minutes. For securing terminals to insulators, a suitable technique is to spray the varnish over the strip material in a thin uniform layer of approximately 0.001-in. thickness. After 24 hours drying and within one week of application, insulators are blanked in the regular manner. The assemblage is built, compressed and bolted, and then baked for one hour at 150 degrees C. Upon partial cooling it is finally compressed under controlled pressure and the bolts tightened. Good securing and reasonable adhesion are achieved. If the baking is carried out at a higher temperature, that is, 30 minutes at 175 degrees C., adhesion is much improved, in fact, it is adequate for the layers of terminals to withstand shock upon disassembly.

This phenolic resin oil varnish permits of further possibilities where the fixing of tags is concerned, allowing much flexibility of method. Thus the blank phenolic laminated insulators may be maintained in stock, drawn by the assembly benches as required, and varnished by means of a roller coating machine. The varnish flashes off so rapidly that it permits of passing the coated pieces along a band conveyor and assembling directly. This contributes an appreciable saving in labour and space, avoiding varnishing in the regular finishing shop, drying racks, and packing, and eliminating at least two handling operations.

The versatility of the phenolic resins is further demonstrated by the availability of a plastic form of the

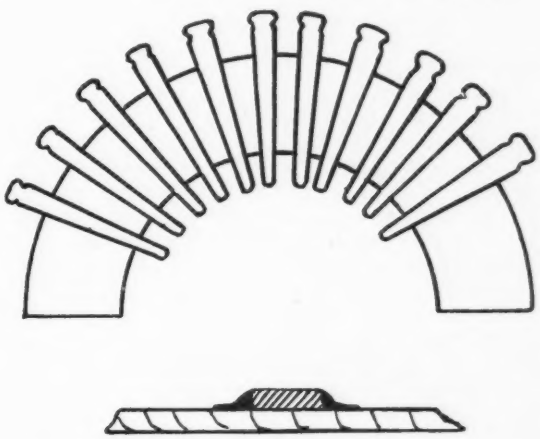


Fig. 9.—Arc of metal terminals cemented to phenolic laminated and, enlarged, the flow-up of varnish.

uncured resin which appears like a brown, hard, putty. It has many uses as a filler or plugging cement, suitable for cavities, crevices, slots, holes, etc. It is useful for covering sunken screw or bolt heads and generally for electrical insulation or the prevention of ingress of water or moisture. It gradually hardens upon keeping, losing much plasticity in 24 hours at 110 degrees C., but retaining it below 50 degrees C. for appreciable periods. With advantage it can be softened by slowly heating by indirect methods, e.g., in a vessel immersed in hot water, after which it can readily be pressed and worked into position.

Mounting of Specimens

This plastic cement is useful for the mounting of microscopic specimens. For example, in metallographic work, the specimen can be laid face down on a flat metal plate and a piece of metal tubing with square cut ends placed around it. The plugging cement is then forced into position and the whole placed in an oven at 100/110 degrees C.; 24 to 48 hours is sufficient to harden the resin, when the specimen can be polished and prepared in the usual way. The resin has advantages over the fusible alloy commonly employed insofar as it does not contaminate the specimen, especially during etching.

Cements for Radio Valves

A number of phenolic resin cements are produced for basing radio valves, and are applicable for similar applications where the interstices between two cylindrical components have to be filled. The requirements for such a cement are suitability for filling without shrinkage and provision of sufficient strength to withstand stresses of pull and twist during fixing of the valve in position. Such strength is not required to be permanent as the articles have limited service life; on the other hand, deterioration by dampness or warmth in storage must not occur.

Requirements of Valve Cements

The same stringent requirements that can be met by mineral-filled liquid cements are not involved. The valve basing cements must be inexpensive and rapid in application because the market is so competitive. Moreover, they must be perfectly uniform over repeat deliveries in order to function satisfactorily on automatic basing machines. Shellac solution filled with mineral matter are extensively used, but most modern valve basing equipment utilizes the phenolic synthetics. They are graded powders, and, similar to normal moulding powders, contain mineral loading with or without wood filler. In use, they are compounded to stiff uniform paste with volatile solvent such as industrial methylated spirit. Girl operatives rapidly become expert in applying this to the inside of the valve cap. The valve leads are threaded through the holes in the cap, the valve pushed home, and the assembly inserted in the heater in a rotary machine. One rotation bakes the cement and the valve is withdrawn. The cements are chosen with respect to loading and particle size to suit the inter-space to be filled. They vary in baking temperature and time, which may range from 100 to 135 degrees C. and 3 to 15 minutes respectively. Obviously the resin is not cured and set in the same sense as the liquid cements already illustrated. Table No. 2 refers to such cements. Sample No. 6 is an excellent general purposes material suitable for baking at 135 degrees C. for 10 minutes. It contains an inert siliceous filler. No. 3 would, perhaps, suit fine interstices, low temperatures and rapid working, but in general would tend to exhibit shrinkage and cracking owing to the absence of filling. On the other hand it can be modified by the user by mineral powder additions to suit the job. No. 4 is similar in nature to No. 6, except containing the less inert calcium carbonate filler. No. 5 is very sound, containing a large percentage of wood flour, and being closer to an ordinary moulding compound. It would advisably be given baking times and temperatures at the top of the range.

The Use of Resin/Rubber Cements

An air-drying synthetic resin/rubber cement comprises a drying oil varnish containing phenol-formaldehyde synthetic resins and rubber. It flashes off quickly to offer a surface having adhesive properties, and finally dries off to give a strong bond. It is cleaner and more reliable than a boiled-oil varnish or gold-size type of adhesive, and easier to apply with neater results. Furthermore, the bond can be removed, when practicable, using a solvent such as coal-tar naphtha. Commercial types are summarized in Table No. 4.

The resin/rubber cements are used for providing waterproof seals. They adhere well to practically any material, and are suitable for applying and partially air drying prior to the spinning over of a metal cap or closing ring. They also serve to produce dustproof and waterproof seals for metal-framed glass windows in instruments. Such compounds may also be employed for sticking paper labels to many materials. In this regard they are particularly useful for fixing paper to plastics. They may also be employed for various joints in metal and glass. A top lacquer (cellulose) may be applied as finish. Detailed examples of their use are as under:—

Resin/Rubber Adhesive—Glass to Metal

These cements are usefully employed for securing window glasses into their frames without additional mechanical fixing. They form dustproof and waterproof seals. Particularly are these cements suitable for making window closures where the window is dropped into position from the outside of the instrument. To gain access to the latter periodically the cement can be softened with naphtha and the glass removed.

There is no reason why the same cement should not serve for securing synthetics, such as Perspex or Astralon, to metal frames. The adhesive is applied to the seating by brush and the window immediately pressed into position.

Resin/Rubber Adhesive—Paper to Metal, Plastic Mouldings, etc.

The general procedure for fixing paper labels, etc., to polished plastic and metal surfaces involves the brushing of a thin coat of the bakelite/rubber cement on to the back of the paper, the coating being allowed to become tacky (this requires one-two minutes) before fixing the label in position on the metal, and pressing firmly into place, using hand pressure, through a layer of cloth. After a minimum time of 30 minutes one coat of topping lacquer is applied. Samples subjected to humidity tests for a period of six months were examined after removal and after allowing 24 hours, in normal atmosphere, for any moisture retained by the paper itself to dry out. Adhesion proved to be unimpaired.

Arochlors

WE have just received from Mr. F. J. Curtis, development director of Monsanto Chemical Co., St. Louis, Missouri, a new booklet giving the physical and chemical properties of these comparatively new materials.

The Arochlors range in form and appearance from mobile oily liquids to fine white crystals and hard transparent resins. They are non-oxidizing, permanently thermo-plastic, of low volatility and non-corrosive to metals. They are not hydrolysed by water or alkalis. The viscous liquids and the resins will not support combustion when heated alone.

The crystalline Arochlors are relatively insoluble, but the liquid and resinous products are soluble in most of the common organic solvents, thinners and oils. The main exceptions are that all the Arochlors are insoluble in water, glycerine or the glycols, and Arochlor 5460 is insoluble in the lower molecular-weight alcohols. Arochlor 4465 is only partly soluble in the lower alcohols.

The excellent electrical properties, fire-resistance and inertness of the Arochlors make them useful in many applications not mentioned in this bulletin.

The properties imparted by the Arochlors and their usefulness for particular applications vary in regular gradients over the series, so that the selection of the right Arochlor for a specific use can generally be made simply by a comparison of the physical properties of the several Arochlors.

Reflections on Synthetic Rubber

By A. A. APPLEBY, B.Sc., M.Inst. Met.

The Historical Development of the Synthetic-rubber Industry is Reviewed Briefly and Some Important Lines of Current and Probable Future Development are Indicated

THE advances made in the development of synthetic rubbers during the past decade will undoubtedly for long rank high amongst the achievements of organic chemists in building up from relatively simple materials a range of products of immediate and increasing industrial value.

Whilst the work has often been referred to as research into the finding of rubber substitutes, the wide range of potentially useful properties possessed by synthetic rubbers—properties, in many instances, not possessed by natural rubber—justify the contention put forward by workers and manufacturers that the products should no longer be regarded in the light of substitute materials. The position has probably been best summarized by Gough,[1] who points out that synthetic rubbers are in reality new raw materials, each with its own characteristic properties and with potential uses to which natural rubber would never be put. They should, consequently, be regarded as being important additions to the "rubber range" of materials.

The Future of Synthetic Rubber

In this respect, Gough points out that rubber technology is developing on scientific lines, similar to those followed by the synthetic dye industry. The use of natural rubber, like that of natural dyestuffs, will not die out; on the other hand, the immense potentialities of synthetic rubbers will undoubtedly be increasingly exploited, as have those of dyestuffs produced by chemical synthesis.

It is as yet too early to attempt to forecast what the precise future of the materials is likely to be, since conjectures based upon their useful properties cannot take into account the somewhat involved economical aspects of the problem, factors which at the present time are even further complicated by the enforcement of "self-sufficiency" programmes in certain countries, notably, of course, Germany, and by the fact that, in certain contingencies, supplies of natural rubber may be difficult to procure.

Effect of War

In the U.S.A., for example, the materials division of the National Defence Advisory Commission are authoritatively stated[2] to have completed preparations for satisfying all requirements by synthetic rubbers in the event of Japan attempting to interfere with shipments of natural rubber from British Malaya.

However, we can but hope that these are merely passing phases, and that with the return of peace the establishment of a sane economic order will allow of developments being made in a rational manner, unfettered by the shackles with which the more turbulent sections of the community have, for the past 10 years or so, seemed determined to burden the human race. Then, possibly, the achievements of scientists will be utilized in full measure for the benefit, and not the destruction, of mankind.

In this respect, it is interesting to reflect that the greatest progress in the evolution of new rubber materials has been made in the two countries which, at the present time, occupy the extreme positions in the militarist scale, namely, in the U.S.A., where the return of peace is desired with a fervour not entirely inspired by motives of self-preservation, and in Germany, upon whose attitude there is no need to enlarge here. This provides at least some hope that recognition of the merits of honourable achievement have not for ever passed from human ken.

Early Production

A most interesting review by Konrad[3] traces the various stages in the development of the more important members of the synthetic-rubber group. The first period, lasting from 1907 to 1919, saw the evolution of Methyle-rubber, which, during the last war, was used in the production of battery boxes for German submarines. Whilst the product is stated to have been leathery and not elastic enough, disadvantages which caused it to fall into disuse after 1919, it left a valuable legacy to future workers in the anti-oxidants and accelerators of vulcanization, which had been discovered during the period of its development.

Development of Buna Rubbers

The second stage, inaugurated in 1926, followed immediately upon the discovery of the potentialities of acetylene and its derivatives as a basis for chemical synthesis. Butadiene, produced from acetylene by way of acetaldehyde, aldole and bulytenglycol, proved to be the most suitable source for two of the earlier types of synthetic rubber; neoprene, which is produced by the polymerization of chlorbutadiene, and Buna N., a polymer of butadiene and acrylic nitrile. The butadiene basis of these products provided, of course, a close chemical relationship to natural rubber.

The stages by which these results are achieved were naturally very protracted and tedious—even such, apparently, as almost to wear out the infinite patience which is invariably associated with German research scientists—and much of the data collected has been kept a close secret. The following points, however, are mentioned by Konrad as marking important steps in the progression towards the final satisfactory Buna materials.

The heating of butadiene at high temperatures results in the formation, after several months, of a rubberlike material. Also, if liquefied butadiene be mixed with a soap solution, an emulsified product is obtained which bears a considerable resemblance to the natural latex obtained from the rubber tree. In this emulsified form

butadiene acquires the property of polymerizing very rapidly. A further important property of butadiene, which will be readily appreciated by synthetic chemists, is the facility with which it combines with metallic sodium. The discovery of reagents (not disclosed by Konrad), which accelerated polymerization and enabled control to be exercised with regard to both size and structure of the ultimate molecule, marked the final steps in the work.

In the range of materials which became available prior to the outbreak of war, Buna 85 belongs to the sodium polymer class, whilst Buna S, like Buna N (the latter now generally referred to as Perbunan) is an emulsified polymer. The product neoprene, as mentioned previously, is a polymer of chlorbutadiene, whilst a rubberlike plastic, also referred to by Gough[1] and known by the name Thiokol, is produced by condensing chlorinated olefines with sodium polyscelphide.

Mechanical and Physical Properties

Each of the above-mentioned products is characterized by good mechanical properties and a greater degree of resistance than natural rubber to the effects of oils and greases, heat and sunlight, and reactive chemical substances, such as ozone. In the direction of individual achievement, neoprene is remarkable in the ease with which it can be bonded to metals and possesses a high degree of flame resistance. Thiokol is extremely resistant to aromatic solvent action, and Buna materials are more or less unique in their excellent behaviour at low temperatures. Thus, it is not surprising that the potential uses of the materials, to which reference has already been made in this journal,[4] cover an extremely wide range. The mechanical properties of some important members of the synthetic group are compared with those of natural rubber in Table I.

TABLE 1

Mechanical Properties of Synthetic and Natural Rubbers

Product.	Ultimate tensile strength. lb./sq. in.	Ultimate tensile strength. kg./sq. cm.	Elongation. per cent.	Hardness Shore Number.	Relative Elasticity.
Natural rubber ...	3,700	260	600	65	50
Methyle rubber...	1,800	125	500	—	10
Buna S	3,900	275	650	65	50
Perbunan ...	4,300	300	600	70	45

Rubber and Politics

The third stage in the development of synthetic rubber coincided, according to Konrad, with the advent to power of Hitler, and has been characterized chiefly by attempts to enforce the adoption of the materials for all manner of purposes rather than by scientific progress. As mentioned previously,[5] such attempts have been slow and tedious, as from their very nature they might well have been expected to be. It will, however, probably best be left to history to pass judgment upon the merits or otherwise of the astonishing attempts of the Nazi regime to provide the scientific planks for their envisaged new order.

As distinct from the discovery of new products, the solving of problems regarding the bonding of synthetic rubber to metals is possibly the greatest advance made towards the maximum utilization of the materials. Until this had been achieved, rubber materials could be used only under compression loading combined with lateral constraint. The ability to bond them satisfactorily to a wide range of metals and alloys, such as irons and steels, light alloys of aluminium and magnesium, etc., and to products such as Bakelite and glass, at once opened up important new fields of application.

Bonding Rubber to Metal

In this direction the use of certain synthetic rubbers offers appreciable advantages over that of natural rubber. When bonding the latter to steel, for example, the metal must first be plated, bonding then being carried out by the application of heat and pressure. In the case of products such as neoprene, however, it is possible to substitute the plating process by the mere painting of the metal surface with a chlorinated rubber solution. With regard to bonding with aluminium alloys such as duralumin and silumin, it has already been pointed out in this journal[5] that the ability to galvanize such materials after the application of the protective Eloxal treatment is a notable advance.

It has for long been recognized that the reinforcing properties of carbon fillers is due very largely to the fine particle size of the carbon. Consequently, it was but natural that research should be directed towards the acquiring of more accurate knowledge on this subject. A technical bulletin[6] recently published in the U.S.A. adds considerably to the data already available and indicates positive directions in which further development of carbon reinforcement might well take place.

Use of the Electron Microscope

In the researches described, the electron microscope has been brought into use in order the more accurately to determine the particle size of carbon reinforcements. The use of normal microscopic methods had indicated the particle diameter to be of the order of 80μ, but the development of ultra-filtration and counting methods led to the discovery that this figure was too high, a value of 50-60μ being suggested as being more accurate.

As a result of examination under the electron microscope, however, further revision of the figure, down to approximately 30μ, has been found necessary. Thus the surface area/volume ratio, instead of being approximately 2,000,000 sq. ins. per cubic in. (based on 80μ), is actually of the order of 5,000,000 sq. ins. per cubic in.

Previous to these latest tests, it had been generally assumed that the high surface area/volume ratio was due to the particles having burred or feathery surfaces, since, with a particle diameter of 80μ, some such structure would be necessary to explain the high reinforcing properties of the carbon. The need for any such assumption is, however, now removed, a particle diameter of approximately 30μ being sufficient to account for reinforcement properties on the score of fineness of subdivision alone. Indeed, recent tests reveal that the common form of the particles is spheroidal with some evidence of the existence of plane surfaces, a general conclusion reached being that the particles may be treated as being isotropic.

Results of Research

The results of this research are likely to be very far reaching, not only on the more efficient employment of the carbon particle surface for reinforcement purposes, but also on the development of production techniques for the particles themselves. The production of particles of more or less regular shape, as compared with that of particles with what is virtually an artificially created large surface area, obviously provides much more latitude with regard to processing and treatment.

With regard to purely chemical aspects of development, one is, of course, faced with the secrecy invari-

ably maintained by manufacturers. Scanning of patent literature, however, indicates that investigations are being actively pursued in several important directions.

For example, researches into the polymerization of butadienes and esters of acrylic acid are being extended in scope so as to cover as many different chemical constitutions and structures as possible.[7] Butadienes containing alkyl, aralkyl or aryl radicals, and acrylic acid esters, containing saturated or unsaturated aliphatic hydrocarbon radicals with four or more carbon atoms, are stated to yield promising results when polymerized in emulsion at 50 degrees C. for a period ranging from 100 to 300 hours. The polymerization of butadiene with acrylonitrile or styrene is claimed to be improved (to the extent of 30 to 40 per cent.) by the use of catalysts such as chloroproprionitriles.

Study of Accelerators

Accelerators of vulcanization are also receiving a considerable amount of attention,[8] successful products having been obtained by the interaction of a mercaptothiodiazole and an arylene thiazole or selenazole. Further accelerators claimed to be extremely successful are being produced by the interaction of certain amines with an aldehyde, the product being then treated with carbon bisulphide. The rate of curing, particularly in the lower ranges of temperatures, is found to be best improved by using secondary cyclohexylamines, the most suitable aldehydes being formaldehyde, acetaldehyde, etc., or acrolein aldehyde, crotinaldehyde, etc.

Production of Chlorinated Carbon Blacks

Imperial Chemical Industries[9] also appear to be carrying out further work on the production of chlorinated carbon blacks. Channel carbon black is subjected to a slow stream of chlorine gas at 600 degrees C. for a period of six hours, the excess chlorine being then removed by nitrogen. The product, which is stated not to differ greatly from the original black, contains approximately 4 per cent. of chlorine. The abrasion resistance remains the same as that of the initial substance, but the resilience and strength are improved and there is a diminution of heat on flexing.

Whilst these are but few of the many lines of development being pursued at the present time, they serve to indicate the comprehensive and thorough nature of the attempts being made by the synthetic rubber industry to raise its products to the highest pitch of efficiency and industrial utility.

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THE EMPIRE WAR EFFORT

(Continued from Last Month)

SOUTH AFRICA

Army.—Another strong contingent arrived in East Africa recently. The Forces included units of the South African Women's Auxiliary Army Service.

Air Force.—The Air Force has been operating from the Sudan over Italian East Africa.

War Industries.—In order to meet the demand for steel a third blast furnace is being constructed at the Iscor works at Pretoria. It is being designed to produce 600 tons of metal a day.

Raw Materials.—Iron ore is now going to the U.K. 17,330 tons were shipped in August.

War Expenditure.—Three War Loans were opened on October 23 for expenditure on defence and public works. Total amount to be borrowed is £30 million, including £20 million for defence.

NEWFOUNDLAND

Army.—A further contingent of the Newfoundland Artillery arrived in the U.K. in the third week of October.

Air Force.—Newfoundland has sent a first contingent of 50 men to be trained under the Empire Air Scheme in Canada. They are members of the R.A.F. temporarily attached to the R.C.A.F.

SOUTHERN RHODESIA

A contingent of 700 R.A.F. airmen has arrived at the training school at Bulawayo.

INDIA

Air Force.—Twenty-four Indian officers of the R.A.F., the majority from the Punjab, have arrived in the U.K.

War Industries

Aircraft.—The Government of India, it is understood, have agreed to purchase in the first instance 50 aeroplanes a year from the new factory at Bangalore.

Tanks and Armoured Cars.—One railway workshop is being adapted for production.

Shells.—In September, civil industry alone machined 9,000 shells and forged 20,000 more.

War Supplies.—Among recent war orders received are: Coal for the Middle East; production parts for armaments; khaki drill and cotton web for Australia.

To conserve the essential supplies the Government banned the export of scrap iron except to British and Allied countries.

In the first year of war exports of raw materials and manufactured goods to British Empire countries increased from £27 million to £93 million. Exports to the U.K. increased to £58,500,000 compared with £41,500,000 last year.

Raw Materials.—A vein of alluvial gold over 80 miles long has been discovered in Cashmere.

Gifts.—Total amounts received for the Air Raid Distress Fund from India as noted in the first published list are over £123,000. Contributions for aircraft received during the month approximate to £600,000.

EAST AFRICA

An East African War Supplies Board representing all the East African territories has been set up at Nairobi to replace the contract system.

The U.K. will probably import 20 million lb. of tea from British East Africa during the year ending March, 1941.

FAR EAST AND INDIAN OCEAN

Ceylon.—Exports of rubber from Ceylon were 10,110 tons in September.

Malaya.—The Volunteer Forces recently completed training, which lasted two months. The Malay Regiment is now at full strength. There are Malay units serving in the Royal Engineers, the R.A.S.C., Anti-Aircraft Regiment and Royal Corps of Signals. The Militia, composed of Europeans called up under the Compulsory Training Ordinance, will soon be fully trained.

Exports of rubber from Malaya were about 49,900 tons in September.

Total cost of the war effort of the Straits Settlements to the end of the year is estimated at $41 million, including a gift of $1 million to the U.K. but excluding the war loan of $25 million which has been sent to the U.K. this month.

Plastics in Medicine and Surgery

DURING the past five years a number of interesting and important applications have been found for plastics in the above fields which vary widely in their nature. Thus, phenolic mouldings are used for X-ray machines because they combine unusually high dielectric properties with high impact strength; surgical instruments are now being fabricated of glass-clear acrylic resin, and surgeon's thread is made of the new polyamide nylon. It is no exaggeration to say that the medical profession, and, for the purpose of this article, that includes the firms supplying it with apparatus, recognizes the great potentialities of plastic materials and their ability to solve many old and new problems. Take only one of these, viz., the difficulty of finding an ideal film-forming substance capable of acting as a vehicle for various antiseptic bodies and yet being devoid of any skin irritant properties. An attempt to solve the problem has been made by an American scientist, who has patented a therapeutic preparation for application to the skin which is made by mixing a resinous, alcohol-soluble condensate of phenol and formaldehyde, capable of leaving a dry film, with alcohol and with a medicinal agent. By the use of the resinous preparation as a vehicle there is left, after evaporation of the solvent, a protective coating upon the skin in which all the added medicinal agents are present and which will act on the skin for a long time. This patent, B.P.505,972, represents the first attempt, so far as the author is aware, of plastics being employed in therapeutic preparations. A certain amount of work has, however, been done on the use of polyvinyl alcohol as a cavity-filling body in surgery, but the data available is rather meagre.

The use of plastics for surgeon's thread or sutures is now receiving a good deal of attention, and evidence regarding its merits is accumulating. Nylon has, according to prominent American surgeons who have tried it out during the past two years, some outstanding advantages. The new suture has a low tissue tolerance, that is, it remains in position unaltered and unaffected by body fluids and exercises no influence on surrounding tissues.

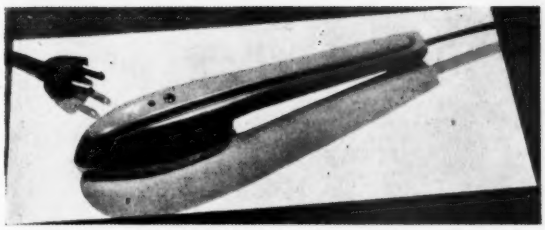
Nylon in single filament form has an added distinct advantage over previous materials used in that it takes up relatively small amounts of moisture, is non-capillary and presents no surface interstices such as silk does for wound tissue to grow into during healing. Non-capillarity is essential in a good suture material because it prevents travel along the strand from one portion of the body to another, or from the outside to the inside, thus limiting the possibility of wound infection. It is, according to the best medical opinion, exceedingly desirable to use a single strand, because, during the healing process, any interstices or openings in the strand usually provide an access for healing tissue to granulate into, so that when a non-absorbable suture is removed from a wound after healing has progressed to the proper point, a further tearing of the tissue surrounding the suture may not result upon extraction of the suture. In addition to these advantages, nylon sutures have excellent tensile strength and can be sterilized and re-sterilized without change and in a short time. It is interesting to note that although nylon now finds its largest outlet as an alternative to natural bristle for tooth brushes, its first use was in surgery for sutures.

A sturdy oil-container for a 90,000-volt X-ray transformer, formed from impact-resistant Bakelite.

Turning now to the applications now being found for plastics in equipment, one of the most interesting is the growing use of transparent thermo-setting plastics for certain parts of the surgeon's mask designed to prevent droplet infection. One of the best-known examples is the Keen's surgeon's mask designed by Mr. Denis Keen, of Chelmsford, and consisting of an adequate face mask and combined spectacle frame. The plastic part is so designed that no misting of the eye-glasses occurs and the weight is so small that no inconvenience is caused. The mask is usually made of cellulose acetate sheet, but it could equally be fabricated of acrylic resin sheet. Transparent and semi-transparent vinyl resin is also being used for a somewhat similar purpose, that is, to prevent droplet infection.

Polyvinyl resin extruded tubes have been suggested for use instead of rubber where these are employed for draining off body fluids. The advantages claimed for the vinyl resin are its complete inertness and low moisture absorption properties, whereas even the finest rubber is affected by traces of grease and will eventually swell. Rubber is also more difficult to sterilize than the vinyl polymer. As vinyl resin can be obtained in a transparent form, this is another advantage, as its use facilitates the work of the nurse.

Much has already been written about the ingenious surgical and dental instruments fabricated of acrylic resin to merit any further comment, but it may be said that the ability of the plastic to conduct light is proving of very great value to the surgeon and dentist.



This new American-made massage device is moulded of Durez phenolic resin.

The beam of light obtained by a small bulb operating off a dry cell battery is free from glare or heat, and there is no risk of electric shock. Acrylic resin instruments cannot be sterilized in the usual way as this plastic softens below 100 degrees C., but they may be kept sterile by using certain antiseptic solutions. The one recommended by E. I. du Pont de Nemours and Co. consists of 1 drop of 1 per cent. aqueous solution of methylene blue dissolved in 4 oz. of 70 per cent. alcohol.

A number of moulded components are now being used in the assembly of various kinds of medical and surgical apparatus, particularly X-ray machines. In America, the oil container for a 90,000-volt X-ray transformer is moulded of impact resistant Bakelite, and moulded parts are also widely used for diathermic equipment. An ingenious all-moulded device is the massage master, also an American production. It supplies a gentle, relaxing warmth to skin and nerve centres and is particularly adapted for use where oil or cream is employed by the masseur. The selection of a phenolic moulding compound for this application was the result of careful investigation. A material which had flexibility in design, an integral, satin-smooth, long-wearing finish, resistance to oils and creams, etc., was required. Incidentally, the use of plastics for this device meant that parts costs were low.

Neoprene Floor Matting

ITS FUNCTION IN OIL FACTORY ECONOMICS

INDUSTRIAL floor matting which provides a non-slip walking and working area is an important contribution to plant safety and efficiency. Careful maintenance of this safe area is of extreme importance as matting which wears out too quickly, or matting which swells and distorts, may present rough irregular edges more dangerous than a floor area not covered by matting.

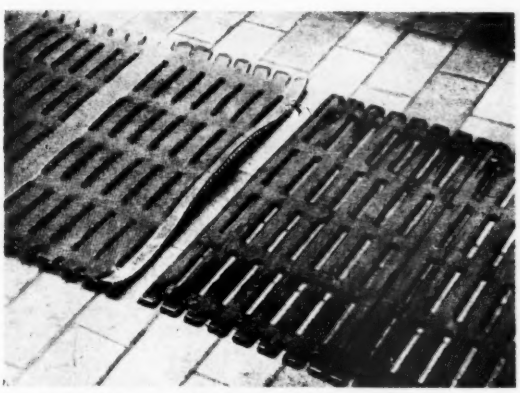
Fortunately, the maintenance problem in many plants resolves itself into periodical inspection of the matting to be certain that it is held in place and that it is not worn out. But in plants where liquids which will attack the matting are constantly falling to the floor, proper maintenance becomes a nightmare. The matting, weakened by exposure to the liquids, either wears out too rapidly and increases maintenance costs, or else it soon swells out of shape and must be discarded as a safety hazard long before it has paid for itself.

This was the problem that faced the manager of a large meat packing plant. He needed floor matting to protect his workmen against slipping, but the animal fats and greases which fell on this matting destroyed its usefulness so rapidly that maintenance costs were much too high. This manager tried all the available types of floor matting, but in barely two months he would have to take out the mats and install new ones.

Naturally, he was thoroughly discouraged about the whole problem, so when he was recently offered a matting combining neoprene and cord on end construction he did not have much hope that this new product would solve his difficulties. However, he tried the neoprene product—he ***had*** to find some solution to his problem.

To his amazement, the neoprene matting continued to do its job for many months longer than any other type of matting previously tried. Installed on the floor in front of the grinding and chopping machines, the matting is constantly subjected to animal fats and greases. In addition, 800 pound steel-wheeled trucks are rolled over the matting many times during the day, and each evening it is washed with high-pressure steam. Despite this extreme treatment, the neoprene mat has continued on the job, giving efficient service, for ten months and is still going strong. A similar rubber matting was badly swollen and distorted in two months, and its surface, softened excessively by the greases, wore away rapidly.

The Neoprene Notebook (August, 1940) contains an interesting diagram showing the relative strengths of rubber and neoprene after immersion in various oils.



Left, a rubber mat and, right, a neoprene mat exposed to the same treatment.

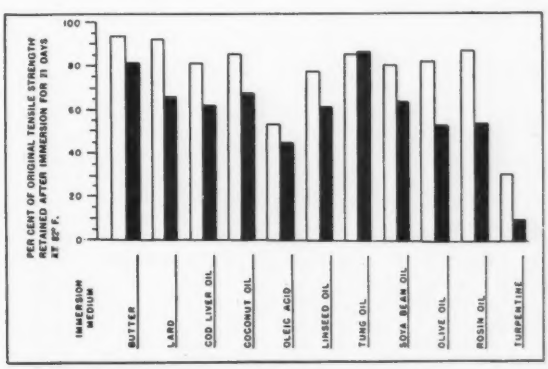


Diagram of relative strengths of rubber and neoprene after exposure to oils. Black rectangles indicate rubber.

PRODUCTION

Practical Information dealing with Raw Materials, Moulding and Forming of all types of Plastics—Thermo-Hardening and Thermo-Plastic—Works-Organization, New Plant and Control Apparatus

NOTES AND COMMENTS

New Moulding Practice

FOR some years past the well-known concern of The British Thomson-Houston Co., Ltd., has been studying a new method of moulding for their own peculiar needs, which are, of course, in the main electrical problems. It is known as the shot-moulding process and is fully described on pages 15 and 16.

As will be seen, it has been developed primarily for pressing and curing insulating covers in the form of resin-impregnated sheet on to coils, but the process also lends itself to the covering of almost any shape with a coating of plastic, whether of a thermo-setting or thermo-plastic nature.

Although we have pointed out that the covering of airscrews gives the process a special interest to-day, peace-time practice will regard the possible manufacture of boxes with great hopes. It will be realized, however, that such a box will be first built up into its shape from impregnated paper or fabric and then submitted to treatment. The chemical industry especially, with the rigid conditions it demands and the comparatively small number of different shapes it requires, should be directly interested. The process appears, in fact, to offer competition to the already well-known Keebush process of Kestner Evaporator and Engineering Co., already mentioned in this journal.

The shot-moulding method has been patented by The British Thomson-Houston Co., Ltd. (B.P. 401,276) and is, we understand, available to those who wish to work it under licence.

It does not, we fear, satisfy the long-felt want of powder manufacturers for a new and cheaper moulding process. But the plastics industry as a whole will see in it a new method of application which widens the spheres of plastics.

The Beetle Magazine

THE Christmas issue is now out and, in spite of all the difficulties of war-time, continues in its normal state of excellence.

Prominent in the news section are the facts that Peter K. Chance has been appointed Deputy Assistant Quarter-master-General and has been promoted to the rank of Major, and that the present Editor, Cyril S. Dingley, has been appointed to the Board of British Industrial Plastics, Ltd. To both we offer our sincere congratulations.

There is also news regarding the activities of the well-known concern of Australian moulders, A.C.I. Plastics Pty., Ltd., of Melbourne and Sydney. Australia is perhaps not so restricted in the manufacture of plastic goods as this country is in war-time, and has been able to attack new problems with great success. In fact some of them are ideas in advance of practice in this country—not for the first time.

One outstanding example is the launching of the moulded bathroom cabinet which has long been given consideration in this country without much progress being made. Australia, with a much smaller market, has launched into production. The "Garnite" bathroom cabinet, made by A.C.I. Plastics Pty., Ltd., is 18 ins. by 12 ins. by 4 ins., with a door hinged centrally to swing across the face of the cabinet. This company is also making lavatory seats, coat hooks and wall lamps, and a noteworthy moulded three-legged bathroom stool about 18 ins. high.

Industry's Task in the New Year

A Message from Lieut.-Col. Lord Dudley Gordon, D.S.O., President of the Federation of British Industries

"During the closing days of 1940 the attention of the whole world was drawn first to Lord Lothian's speech delivered for him by another immediately before his death in America, and then to the statement on the war by the Prime Minister in the House of Commons.

"Both these pronouncements emphasized that 1941 must be the critical year for the British Empire and for the cause of freedom in the world. This coming crisis in 1941 can only be met by the successful endeavours of industry to supply the fighting forces, with which it is proud to be in partnership. The great industrial effort in the United States, added to our own, will ensure overwhelming superiority by 1942, but it is industry in Great Britain which has to bear the strain and provide the main requirements of 1941. Industry will not fail to respond to this urgent call for redoubled efforts in spite of enemy attempts to terrorize and to destroy.

"To achieve our purpose there must be rigorous cutting down of unessential goods and services. At the same time, it is necessary to exercise the utmost care in planning in order that man power and productive resources thus released shall be quickly reabsorbed. In this effort, as in others, the Federation of British Industries has kept in consultation with the Government and will continue to give its active co-operation in order that dislocation and delay may be reduced to a minimum.

"I have no doubt that the coming year, stern and arduous as we may expect it to be, will lead us and the world to the success of our cause—freedom."

MOULDING WITHOUT MOULDS

Some Notes on the Shot-moulding Process Developed by The British Thomson-Houston Co., Ltd.

IT can be said with considerable truth that the electrical industry is responsible to a great extent not only for the growth of the plastics industry but also for much of the theoretical and technical research work that has been carried out on the materials of our industry. We presume that considered as an entity the electrical industry utilizes more different types of plastics and more different methods of fabrication of finished goods than any other consuming industry. Of the methods of fabrication employed, that of shaping and pressing insulating materials of the paper- and fabric-impregnated type is one of the most important. It is with special reference to this type that the following notes deal.

A typical example of the mechanical and economic difficulties that face the industry is as follows. Given, say, a conducting coil of special size and shape which must be protected by an insulator, it is obvious that the use of an expensive mould makes the whole manufacturing system prohibitive when the total number of coils required is small—in some cases only half a dozen may be required. Furthermore, when coils contain evolutes or twisted forms the matter is still more aggravated and is, indeed, sometimes rendered impossible by orthodox moulding processes.

In our last issue we made mention of a paper* recently written by R. I. Martin, A.M.I.E.E., of The British Thomson-Houston Co., Ltd., on a new process of moulding, termed shot-moulding, which overcomes many of these problems and which opens up possibilities in other spheres in the application of plastics to industry.

The Process of Shot Pressing

In essence the new process takes advantage of the fact that hot steel shot (approximately 40/1,000 in. diameter is used) when under pressure will act similarly to a fluid and transmit pressure and heat to all points and within limits in all directions when required.

The method of procedure is, therefore, as follows. The object, covered with its insulating protection in the form of, for example, resin impregnated strips which are to be pressed and cured around it, is placed in a strong moulding box, the spaces between object and box being filled with hot steel shot. It will be obvious that during the curing process the shot must be prevented from adhering to the "fluid" resin of the insulator. This is avoided by first covering the insulating surface with a layer of special rubber which is afterwards removed.

The top of the box is then closed with a thick steel plate which in effect becomes the plunger which transmits the pressure from a hydraulic press to the shot. It is of considerable interest to note that this plunger need not provide an airtight joint, but need only be sufficiently close to prevent the passage of the 40/1,000-in. shot. The whole box is then transferred to a hydraulic press, the combined pressure and the heat of the shot which flows and presses round the object, completing the curing of the resin impregnated material.

The view of the moulding box and press given in the accompanying photograph shows clearly the type of equipment used and the whole method. The moulding box, which is built up of welded thick steel plates, is roughly 1 ft. wide by 4 ft. long and is fitted with steam tubes for maintaining the temperature (about 150 degrees C.). Within the box can be seen an insulated coil surrounded by the steel shot which is fed in from the cylindrical hopper above. This hopper, too, is steam heated so that the shot enters the box already in a hot condition. It is of interest to point out at this juncture that this moulding box can obviously deal with one long and large object or a number of small ones, the process being quite independent of the shapes

The Electrical Times, November 7, 1940.

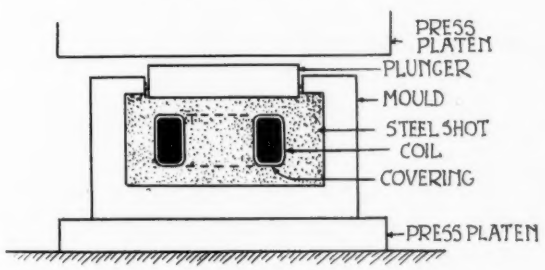


Fig. 1.—General arrangement of moulding box for moulding a coil.

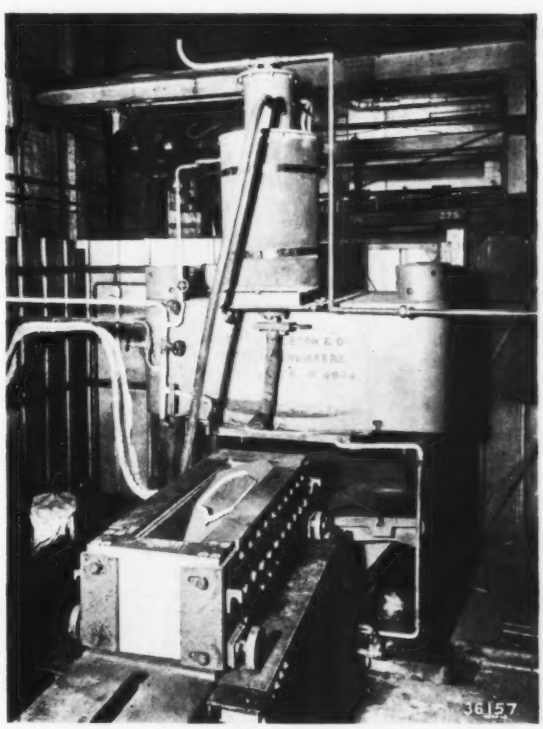


Fig. 2.—The complete plant, showing moulding box. In the rear is seen the hydraulic press and the shot hopper.

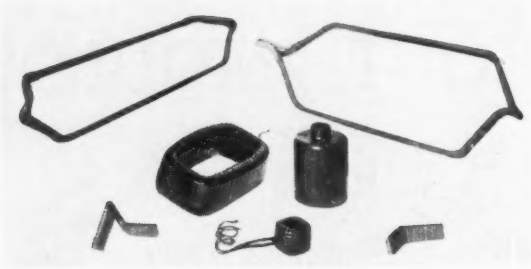


Fig. 3.—Range of coils moulded by the shot process.

of the objects. Thus most of the objects shown in Fig. 3 could, if desired, be moulded in the one box at the same time.

As we have already indicated, the process is especially suitable for moulding or rather pressing insulating coverings on to the outer surface of objects and becomes economically important when variations in size are common and where the use of a rigid mould which is suitable for only one size is prohibited. The process, too, lends itself admirably to the production of a few experimental objects and to repair work.

Here it is worth while repeating in detail the description by Mr. Martin of a typical production:—

A field coil of a d.c. motor was required to be completely encased in an impervious insulating covering in order to render it resistant to ingress of water if totally submerged. As only one set of four such coils was required, the use of a mould for moulding a covering on to the coil was out of the question, and, in any case, the variations between individual coils would have made the use of a rigid mould uncertain. It was, therefore, wrapped "through and through" with synthetic resin-treated cloth cut into strips and taped half-lap. A final taping of strips of a special flexible sheet rubber was applied all over and the coil embedded in hot steel shot in a moulding box, the shot having previously been heated to about 150 degrees C.

Pressure was then applied to the shot by means of the plunger in the top of the moulding box and the temperature and pressure maintained for about half an hour to ensure the thorough curing of the synthetic resin-treated cloth. On removing from the hot shot, the rubber strip was taken off and, apart from the ridges formed by the overlapping of this strip, the surface of the covering was a complete uniform coating of well-bonded synthetic resin fabric compound. The outstanding feature of this case was the fact that the outer wrapping was completely pressed to the coil and followed every irregularity, thus ensuring that there were no air spaces under the outside covering. Further, the material effectively sealed the insulation around the leads and connections, so that ingress of moisture at these points was prevented. These are the most difficult points to safeguard when insulating such coils by ordinary methods using tapes and varnish treatments, etc. These particular coils were finally varnished.

Covering Objects With Plastics

An extremely valuable outcome of the shot process is the ability to press exterior plastic coatings or coverings on to shaped objects. Thus, a tapered bonded paper tube, which cannot be made by the usual rolling methods, is readily produced by wrapping resin-treated paper round a tapered mandrel and submitting it to the shot process.

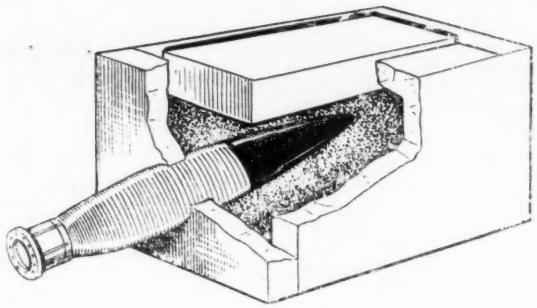


Fig. 4.—The method as applied to the coating of airscrews.

Perhaps of greatest interest at the moment is the ability of pressing protective coverings on to airscrew blades, to achieve results analogous to the Schwartz process of covering blades with a cellulose-acetate film. This process of covering blades was developed by The British Thomson-Houston Co., Ltd., utilizing a thermoplastic resin. It will be readily seen how advantageous becomes the shot-moulding process, since otherwise a large and costly mould would be necessary to press round a blade of such complicated aerofoil design. Moreover, the process is fluid enough to "take care" of the slight changes in size that are unavoidable in airscrew manufacture. It will also be noted that, again because of the nature of the shot, the whole airscrew need not rest entirely within the moulding box, but can be inserted through a hole in the side. Thus, a portion of the blade may remain outside the box.

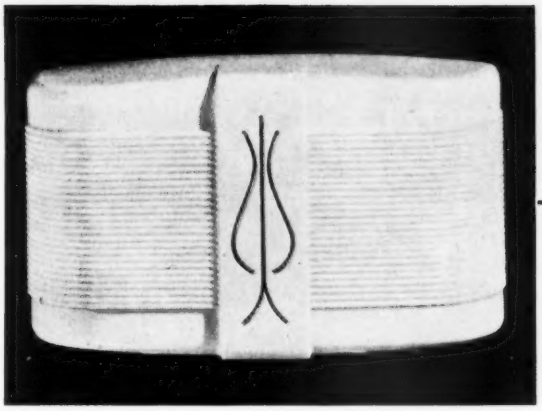
Hollow Articles

A most useful application is that of the ability to produce hollow objects, such as boxes, and, moreover, boxlike objects with a small opening. The use of a rigid split mould entailing removal of the internal sections would often be quite impossible. Shot, on the other hand, simply flows from the hollow portion.

An interesting development, too, is the ability to mould using metal formers. This is readily seen in the photograph below, which shows an annular moulding made by covering a metal ring with strips of resin-impregnated fabric and finally rubber strip. A plastic helmet, using a standard steel shrapnel helmet as the former, has also been made.

We are indebted to The British Thomson-Houston Co., Ltd., for permission to view the plant, and to Mr. Martin for his detailed explanation of its working.

Fig. 5.—Annular moulding with special moulding box.



NOTES ON THE DESIGNING OF PLASTICS

We have culled the following notes from the current issue of "Durez Plastic News," to which periodical we are greatly indebted

ALMOST every engineer is called upon some time or other to design moulded plastic parts. When the piece is to be a housing, cover or other external element where appearance is important he may find this job not easy because plastic materials have definite properties and limitations. What makes an attractive piece in one material, a plated stamping for example, will not necessarily make an attractive plastic moulding. In black phenolic material, of which about three-quarters of all plastic mouldings are made, the job is even harder, because a black, undecorated phenolic piece has little surface interest of its own.

There are rules, however, that the designer can follow which will help him to achieve attractive moulded parts. Perhaps the two most important rules are: (1) Do not consciously strive to be modern or modernistic by means of eye-tiring designs on the surface. (2) Strive for simplicity, remembering that a moulded part, like a machine, is best when it is simple.

For specific rules we can safely indulge ourselves in a generalization when we say: Avoid flat moulded surfaces. Flat surfaces are inherently uninteresting in that they throw no highlights. Often flat surfaces seem to be called for, and often are the least expensive, but if appearance is important curve the surface, even if only slightly, so you are sure of at least one highlight from any angle. You will find that the highlight emphasizes the lustre and sleekness of the moulding.

There are no general rules one can lay down on the contours of a moulding, since contours are often largely dictated by its function, and unless an engineer has an inherent sense of proportion he should let the function dictate the shape, smoothing and simplifying it as much as possible.

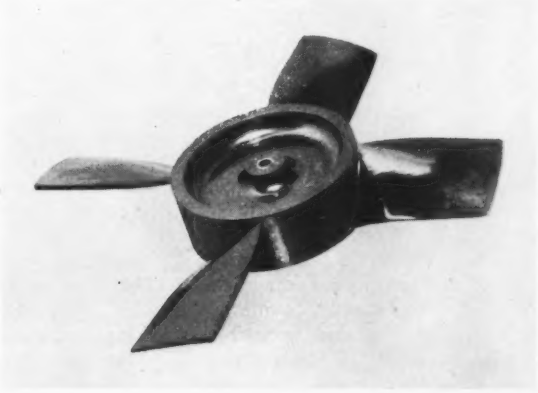
Quite often, however, the engineer's inherent desire for simplicity in a moulded part will be overcome by a feeling that his moulding lacks interest or contrast, and then arrives the problem of surface decoration and how to approach it. This need is usually more apparent where fairly large flat surfaces are unavoidable and there is no opportunity for highlights or integral or attached parts to break up this surface. Also, unless special care is taken to avoid it, large flat mouldings tend to show a slight waviness caused by the flow of the material in the mould, and perhaps also a slight orange-peel effect. This is not noticeable as a rule on curves or cylindrical objects. Where flat surfaces cannot be avoided it is often wise to use a surface treatment of some sort to minimize waviness or to achieve the needed contrast.

Decorative treatments can take many forms and it is up to the designer to adapt the ones most appropriate and practical. Typical examples of these decorative techniques are shown in the accompanying illustration.

Perhaps some of these techniques need a word of explanation. Some are usually employed to achieve a series of concentrated highlights to contrast with a smooth, undecorated surface. Or they may be used entirely to cover portions of a small object, as, for instance, the fluting of all four sides of a check-writer housing.

Relief Engraving

Relief engraving is a little more pretentious, in that it usually involves considerable hand work in making the mould—unless entirely geometric—and consequently is more costly. Used judiciously, however, it can add considerably to the richness of a moulded piece, but it should not be attempted by an untrained man.



"The time and thought spent on the designing of plastics as such, bear a very close relation to the success of the finished goods"

Concentric shiny ribs or flutes in a series or other relief engraving thrown out in relief against a satin-finished background is another method to achieve rich decorative treatment. It accentuates the lustre of the surface and makes a practical finish for an article that will receive a great deal of handling. Wiped-in engraving, as with bas-relief engraving, cannot usually be employed to fullest advantage, except by an experienced man. In practice, the mould is engraved in such a way as to produce depressed lines in the moulded piece, which is subsequently painted with lacquer or pigment and wiped off, leaving the colour only in the sharply cut depressed design.

Bas-relief Decorations

Other decorative methods include the control of highlights by using different planes or achieving a change of direction in a series of steps or set-backs, in which rounded edges on the steps will catch a stronger highlight and eliminate the feeling of too much jaggedness. One technique that offers possibilities is the combination of a bas-relief-engraved surface on which lacquer has been daubed and buffed off before entirely dry, which leaves the colour in the low spots only. Cream-coloured pigment on a moulded brown surface, for instance, makes a pleasing effect.

Finally, one of the most popular methods of achieving interest and contrast in moulded parts is the use of contrasting metals, plated chromium, copper or gold, or the use of contrasting plastics to form the components of a moulded piece. Often dull-finished metal on a lustrous moulded surface achieves a greater richness than when the metal is shiny.

A word should be said here about the relative costs of moulds involving these various decorative techniques. As most of us know, the dies used in moulding plastic materials are made of a high carbon steel, either ground or machined with lathes and grinders or hobbed to the proper shape and polished. It naturally follows that the least expensive decorations are those that can be cut by a milling machine or shaper. Thus, a series of ribs can easily be obtained on moulded pieces by machining the surface of a mould, whereas an intricate design for a wiped-in engraving job requires hand labour. Fluting can sometimes be obtained by ordinary machining in the mould, depending upon the places used, but relief engraving on anything but a small surface must be done by hand in each cavity.

Metal Inlays

A recess in the moulded piece to take an inlay of metal or sheet plastic, such as cellulose acetate, can easily be machined, and satin finish on a mould can be obtained by sand-blasting or by engraving fine grooves by machine. Of equal importance is the final polishing of a mould, and here some designs make polishing easy and others make it difficult. Sharp edges and projections require careful hand work in polishing, so that a rounded edge with a $\frac{1}{2}$-in. radius is a much easier polishing job than a sharp or small-radius corner. Also, beware of designing a piece wherein three plane surfaces come together to form a sharp point, since it is impossible to get a power polishing tool into the corner to polish this portion of the mould and a smooth job is difficult.

On small plastic mouldings the hobbing process of making duplicate mould cavities is used. This eliminates nearly all of the hand work in die-making—once the hob is completed, of course. Generally speaking, it is used most frequently where eight or 10 or more duplicate cavities are needed. Also, moulds for making such parts as camera cases, medium-sized shallow trays or housings up to 4 ins. or 5 ins. in diameter are usually made this way. The method consists of machining a pattern of the moulding in hard steel and forcing the pattern into the die steel under about 50,000 lb. per sq. in. pressure, thus producing an exact duplicate of the pattern negative form. This method permits much greater intricacy and decoration at little extra cost. It is evidently wise to find out how the moulds are to be made before proceeding with the design of the part to be moulded, as the die-making method may make possible economical decorative effects or make their cost prohibitive.

There is always the danger of decorating the surface of a moulding to such an extent that it becomes a dust-catcher and fails to convey the feeling of efficiency, so important on mechanized objects. A feeling of restraint is vital here, and it is always safer to lean too far in the direction of simplicity than to overdo any design technique. When in doubt do not decorate.

The present vogue for so-called streamlining can also be overdone, but all in all its effect on design trends has been healthy, especially for plastics. Moulding material takes naturally to smoothly curved contours. Flowing lines and the absence of violently decorated surfaces in well-designed modern pieces increase a moulding's inherently pleasing tactile impression. When "streamlining" a moulding consists of smoothing off bumps, bosses, sharp corners and other excrescences and "tear-dropping" formerly jagged or bumpy shapes, then we believe in it.

Wiped-in Lettering

Another method of achieving contrast in a moulded piece is by the use of either wiped-in lettering or contrasting labels. Here, again, experience and training in decorative art is vital. Dozens of excellent engineering jobs have been spoiled by the fatal mistake of having the engineer step out of his province into that of the artist. Lettering is an art of its own and few toolmakers or engineers are qualified to do good typographical layout work. The extra cost of having a lettering job laid out by an experienced artist is slight and makes a world of difference in the appearance of the finished piece.

" Cellophane " for Burn Dressings

We do not know if the makers of " Cellophane " cellulose film keep a record of all the uses of this material, but it is always interesting to report a new one. The *Nursing Times* of December 28 describes a case of severe burning the recovery from which was aided by the application of the film. Following a silver nitrate and tannic acid treatment, " normal saline baths were given to both hands and the coagulum was removed as it became softened and loose. The hands were dressed with lints soaked in normal saline solution applied over strips of sterile ' Cellophane.' The ' Cellophane ' prevented the dressings from adhering to the raw surfaces and floated off readily when the hands were immersed in the baths."

" Cellophane " receives another fillip from the Horder Committee which recommends its use as a mask in air-raid shelters. But it is puzzling to read in this recommendation " The cellulose acetate (' Cellophane ') mask is considered to be the best for standard purposes since ' Cellophane ' is not cellulose acetate." Probably the expression should read cellulose acetate or " Cellophane " or cellulose film (" Cellophane "). Perhaps British Cellophane, Ltd., will point out the error to the Horder Committee.

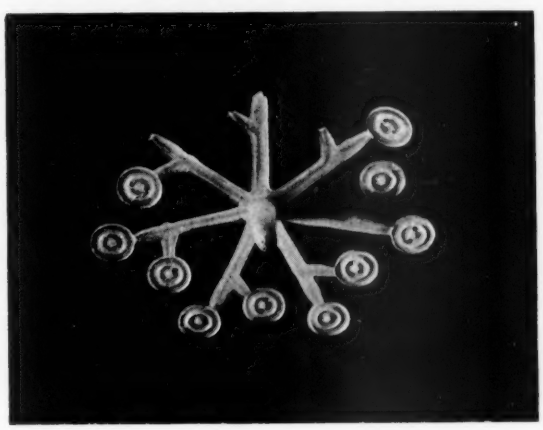
Inquiries and Answers

(In Which is Included General Correspondence)

IMPORTANT NOTICE: If inquirers wish to receive replies by post, a stamped and addressed envelope must be included in their letter. It is understood that the submission of a problem to the Editor permits its publication in this journal.

Injection Moulding Costings

Your American correspondent, Mr. D. A. Dearle, does well to draw attention in his article in your last issue to the need for realizing that in the process there is some loss of raw material. It has often been stated by the purely theoretically minded that because thermo-plastics are in fact thermo-plastics, all "waste" material from the moulding such as gates, etc., can be returned to the hopper so that 100 per cent. efficiency is arrived at. On the other hand, it has been my experience that reputable manufacturers of plant point out with



emphasis the snags that arise, that gates and runners can be a high percentage of the moulding and that to transform them to powder again must entail some cost and on occasion must be considered as irrecoverable. The main point is that accurate costing is as important in injection moulding as in high-pressure moulding.

You may be interested in the injection moulding I am enclosing herewith and in finding out the relative weights of mouldings and "waste." This is, of course, a rare case. PLASTICUS.

Manchester.

[EDITOR'S NOTE.—The photograph shows the injection moulding; four buttons are missing. The 10 weigh 0.78 gram and 14 would weigh about 1.1 grams. The gate and runners weigh 1.625 grams, so that of a total of 2.725 grams the "waste" is nearly 60 per cent.]

Acetate Tubing

As you may be aware, we are regular readers of your journal *Plastics* and it has occurred to us that you may be able to help us with the following:—

We are anxious to obtain, for experimental purposes only, a 2¼-in. length of 2¼-in. o/d by 1-32-in. wall, transparent tubing similar to Bexoid.

We shall be grateful if you will pass this inquiry on to the firm you consider most likely to be able to assist.

We would add that provided the experiment is a success, it is probable we should need similar tubes in quantities of several thousands.

London. THE SPERRY GYROSCOPE CO., LTD.

[EDITOR'S NOTE.—It is highly unlikely that a die exactly of this size is in existence for making extruded cellulose acetate tubing, that is, tubing of the seamless variety. However, the inquirer should write to BX Plastics, Ltd., to Exceloid Co., Ltd., who make the tubular material for handrail insulation, or to F. A. Hughes and Co., Ltd., who might be able to advise.

Since the problem is only experimental it is far simpler to make the tube from 1/32-in. sheet by folding round a circular rod 2¼-in. diameter and sealing the joint with solvent or cement. This could be done by any worker or more expertly by concerns such as Thermo-Plastic Products, Ltd., Phipps Plastic Products, Ltd., etc.]

Plastic Weave

We shall be glad if you will be good enough to let us know the manufacturers of the enclosed sample of plastic weave material which is presumably of cellulose acetate. HOWARD WALL, LTD.

London.

[EDITOR'S NOTE.—We do not believe weave of this type (the acetate thread is roughly 10/1,000-in. thick) was ever made in this country, although interesting examples of what could be done were shown by May and Baker, Ltd., at their showrooms in London before the war. The sample is most probably of French origin. We believe an American concern, Freydber Bros., Inc., is carrying out similar work and are producing ladies' belts of similarly woven material. British manufacturers cannot now produce such "fancy" material unles it is for export.]

Plastics for Art Work

Since I am interested in the use of plastics as a craft in a School of Art, to enable students to obtain some practical knowledge before entering the Design section of the Plastics industry, I should be glad if you would put me in touch with some of the firms whose products could be used in this way.

Expensive presses and moulds are at present out of the question. But carving, modelling, twisting, flat built-up work and simple plaster moulds are feasible.

R. W. HAMILTON JONES,

Scarborough. Scarborough School of Art.

[EDITOR'S NOTE.—It would seem that the following materials could be worked by your students:—

(a) Casein plastics in the form of rods and sheets, obtainable from BX Plastics, Ltd., and Erinoid, Ltd.

(b) Cellulose acetate sheets obtainable from British Celanese, Ltd., and BX Plastics, Ltd.

(c) Cast phenolic resin in rod, tube or sheet form obtainable from Catalin, Ltd.

(d) Methyl methacrylate resin in sheet or cast form, obtainable from Imperial Chemical Industries, Ltd.]

NEW MATERIALS—NEW PLANT—NEW METHODS

The Beken "Duplex" Mixer

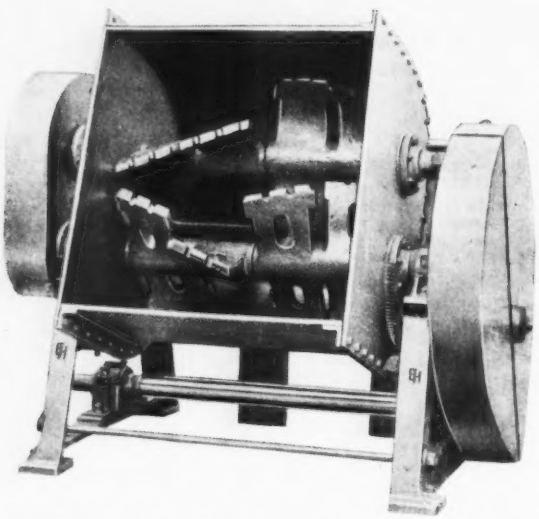
With the rapidly increasing production of all types of plastic material, as solid mechanical mixtures, solutions in alcohol and other solvents and in the plasticized or pasty form, efficient mixing, both from the physical and economic points of view, is of special importance.

The Beken "Duplex" Mixer is equipped with two parallel shafts, each fitted with paddles or blades specially designed to suit the requirements of each mixing problem. One shaft revolves at twice the speed of the other and yet the blades intermesh so closely that the tips of one set of blades only just clear the bosses of the opposing set of blades. The blades sweep the bottom and sides of the pan clear of material, so that at each complete revolution all the ingredients are lifted from the bottom and are squeezed and kneaded between the blades. From this it will be seen that all the work is done between the blades and not between the blades and the pan, as in other forms of mixer. An additional feature is the provision in the fast set of blades of apertures, of a size to suit the nature of the materials in each instance. This adds a spewing action and increases the rapidity and efficiency of the mix. All constituents of a mix are reduced to a homogeneous state of the highest possible quality in a minimum time and at a relatively low cost for power.

The Beken "Duplex" combines simplicity of design with robustness of construction, only the best materials being used. Consequently, cost of renewals and maintenance is low.

Machines can be supplied with Vee belts, chain and sprocket or direct-coupled motor drives when required. Machines may also be supplied with fast and loose pulleys and belt-striking gear, or the driving shaft can be keyed to customer's pulleys.

Standard pans are of mild steel plate and of robust construction. They can be supplied with renewable manganese steel liners where the material is of an abrasive nature. Pans can also be jacketed for steam, oil, water, etc.



The Beken "Duplex" Mixer.

The paddles are made from cast iron, steel castings, bronze or stainless steel to suit the application, and can be supplied with renewable manganese steel tips if necessary.

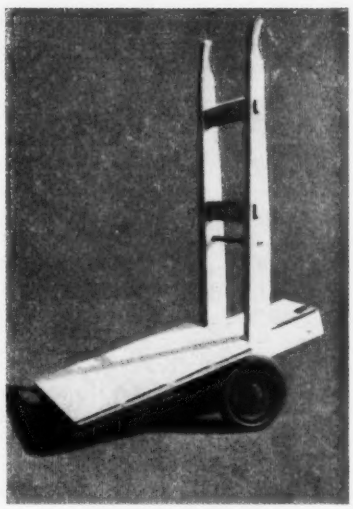
The tipping mechanism is a quadrant and worm drive, except in the very small sizes, when it is a direct lever action.

The quadrant tipping mechanism can be fitted with a separate, reversible, electric motor direct-coupled through flexible coupling and fitted with a push-button control. Non-tipping types are supplied with bottom discharge.

Vacuum can also be applied to the mixers.

The Brig Truck

We have received a pamphlet from E. R. Briggs, of Rugby, relating to a new truck for works use. It appears to be intelligently designed for labour saving and is in fact "a two-wheel lifting platform hand truck." All that is needed is to wheel it under the stillage, bring the handles down when the load is balanced for wheeling away.



The Brig truck.

Cemented Carbides

"The Manufacture and Use of Cemented Carbides" is a pamphlet written by H. Burden, B.Sc., of the Brown-Firth Research Laboratories and published by Thos. Firth and John Brown, Ltd. It was the subject of a paper read before the Institute of Production Engineers, and deals with the nature of the constituents, structure, manufacture of tools, the application of carbide alloys, tool design, etc. Copies of this important pamphlet can be obtained free of charge by writing to the Sheffield offices.

B.E.N. Foot-operated Air Valves

There are so many duties which machine operatives can perform only with their hands that any device enabling foot control to be applied is well worth consideration since the hands are left free for other work. With this in mind, B.E.N. Patents, Ltd., of High Wycombe, have produced a foot-operated air valve designed for floor mounting which can be used to control compressed-air-operated machines or cylinders requiring a straightforward "on" and "off" control. An alternative model provides "on" and "off" control with a free exhaust when in the closed position and, amongst other things, is suitable for actuating single-acting cylinders requiring immediate exhaust after a power stroke.